

Patent claims

1. A programmable echo cancellation filter for echo signal cancellation for a transceiver having:
- (a) a signal input (13) for receiving the transmission signal emitted by the transceiver (1);
  - (b) an input resistor (36) connected to the signal input (13);
  - (c) an operational amplifier (39), whose signal input (38) is connected to the input resistor (36) and whose signal output (41) is connected to an output resistor (43);
  - (d) a first programmable resistor circuit (48), which is provided between the signal output (41) of the operational amplifier (39) and the signal input (38) of the operational amplifier;
  - (e) a second programmable resistor circuit (51), which is provided between the output resistor (43) and a signal output (15) of the echo cancellation filter (14);
  - (f) a third programmable resistor circuit (55), which is provided between the first programmable resistor circuit (48) and the signal output (15) of the echo cancellation filter (14);
  - (g) the programmable resistor circuits (48, 51, 55) each having a plurality of resistors (65) which are terminated in parallel and are

connected to a first terminal (68) of an associated controllable switch (66),

(h) the controllable switches (66) having a second terminal (69) connected to a virtual reference voltage terminal with a very low voltage swing.

2. The programmable echo cancellation filter as claimed in claim 1, wherein the controllable switches (66) of the programmable resistor circuit (48, 51, 55) each have a control terminal (67) which is connected via a control line (19) to a control circuit (21) for setting the resistance of the programmable resistor circuit (48, 51, 55).
3. The programmable echo cancellation filter as claimed in claim 2 wherein the control circuit (21) is a DSP processor.
4. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein the controllable switches (66) are MOSFET transistors having controllable gate terminals.
5. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein a capacitor (58) is provided, which is connected to a low-impedance node (61) of the echo cancellation filter (14).
6. The programmable echo cancellation filter as claimed in one of the preceding claims,

wherein

the controllable switches (66) of the first programmable resistor circuit (48) are connected to the signal input (38) of the operational amplifier (39) as virtual ground terminal.

7. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the controllable switches (66) of the second programmable resistor circuit (51) and the controllable switches (66) of the third programmable resistor circuit (55) are connected to the signal input (27) of an operational amplifier (28) of an automatic gain control circuit of the transceiver (1).
8. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the echo cancellation filter (14) is supplied with a low supply voltage.
9. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the echo cancellation filter (14) is of fully differential construction.
10. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the echo cancellation filter (14) is a first-order analog low-pass filter.
11. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein

the echo cancellation filter (14) is a higher-order analog low-pass filter.

12. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the signal input (13) of the echo cancellation filter (14) is connected to a signal matching circuit (11) for signal matching of the transmission signal.
13. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the signal output (15) of the echo cancellation filter (14) is connected to an automatic gain control circuit in the reception signal path of the transceiver (1).
14. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the resistors contained in the programmable resistor circuits (48, 51, 55) have weighted resistances.
15. The programmable echo cancellation filter as claimed in one of the preceding claims, wherein  
the gain ( $H_1$ ) of the echo cancellation filter (14) is adjustable in a frequency range lying below the first cut-off frequency ( $f_U$ ) and  
the gain ( $H_2$ ) of the echo cancellation filter (14) is adjustable in a frequency range lying above a second cut-off frequency ( $f_O$ ), by the control circuit (21).

16. The p. grammable echo cancellat on filter as claimed in one of the preceding claims, wherein the two cut-off frequencies ( $f_u$ ,  $f_o$ ) of the echo cancellation filter (14) are adjustable by the control circuit (21).
17. A transceiver for xDSL signals, which contains a programmable echo cancellation filter (14), as claimed in claim 1.